Claims

1-19. (canceled)

20. (amended) An ~~off-axis~~ optical imaging system configured to form an image of an object, the optical imaging system comprising:

a catadioptric optical system having an optical axis and configured to form an intermediate image of a predetermined area of the object, wherein the ~~intermediate image~~predetermined area of the object is displaced from the optical axis; and

a refractive optical system configured to form an image of the intermediate image, wherein at least one of the catadioptric optical system and the refractive optical system includes an aspheric optical surface.

21. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein ~~a maximum~~ an image-side numerical aperture (NA) of the ~~off-axis~~ optical imaging system ~~includes a numerical aperture of~~ is 0.6.

22. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein an image height on the surface is at least 10 mm.

23. (amended) The ~~off-axis~~ optical imaging system of claim 20, further comprising a reflective surface arranged to direct a light flux from the catadioptric optical system to the refractive optical system.

24. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the refractive optical system includes an aperture stop.

25. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric optical surface is a refractive optical surface.

26. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric optical surface is a reflective optical surface.

27. (amended) An exposure apparatus comprising:

a laser situated to illuminate a reticle;

a substrate; and

the ~~off-axis~~ optical imaging system of claim 20, situated and configured to form an image of the reticle on the substrate.

28. (amended) An ~~off-axis~~ optical imaging system for forming an image of a predetermined area of an object on a surface, the ~~off-axis~~ imaging system comprising:

(a) a catadioptric optical system that forms an intermediate image of the object, the catadioptric imaging system including:

(i) a concave mirror, and

(ii) at least one diverging lens arranged such that a light flux from the object propagates through the diverging lens to the concave mirror and is reflected by the concave mirror to the diverging lens; and

(b) a refractive optical system that forms an image of the intermediate image on the surface, wherein at least one of the catadioptric optical system and the refractive optical system includes an aspheric optical surface.

29. (amended) The ~~off-axis~~ optical imaging system of claim 28, wherein ~~a maximum~~ an image-side numerical aperture ~~includes a numerical aperture of~~ of the imaging system is 0.6.

30. (amended) The ~~off-axis~~ optical imaging system of claim 28, wherein an image height on the surface is at least 10 mm.

31. (amended) The ~~off-axis~~ optical imaging system of claim 28, further comprising a reflective surface arranged to direct a light flux from the catadioptric optical system to the refractive optical system.

32. (amended) The ~~off-axis~~ optical imaging system of claim 28, wherein the refractive optical system includes an aperture stop.

33. (amended) The ~~off-axis~~ optical imaging system of claim 28, wherein the aspheric optical surface is a refractive optical surface.

34. (amended) The ~~off-axis~~ optical imaging system of claim 28, wherein the aspheric optical surface is a reflective optical surface.

35. (amended) An exposure apparatus comprising:

a laser configured to direct an ultraviolet flux to a reticle;

a substrate; and

the ~~off-axis~~ imaging system recited in claim 28, situated and configured to form an image of the reticle on the substrate.

36. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric surface is configured to compensate a high order aberration.

37. (amended) The ~~off-axis~~ optical imaging system of claim 36, wherein the aspheric surface is configured to compensate at least one of distortion and astigmatism.

38. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric surface is configured to compensate at least one of distortion, pupil spherical aberration, manufacturing error, and astigmatism.

39. (amended) The ~~off-axis~~ optical imaging system of claim 38, wherein the aspheric surface is axially symmetric.

40. (amended) The ~~off-axis~~ optical imaging system of claim 38, wherein the aspheric surface is axially asymmetric.

41. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric surface is axially symmetric.

42. (amended) The ~~off-axis~~ optical imaging system of claim 41, wherein the aspheric surface is configured to compensate at least one of distortion, pupil spherical aberration, and manufacturing error.

43. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the aspheric surface is axially asymmetric.

44. (amended) The ~~off-axis~~ optical imaging system of claim 43, wherein the aspheric surface is configured to compensate at least one of astigmatism and manufacturing error.

45. (amended) The ~~off-axis~~ optical imaging system of claim 20, further comprising a first reflective surface situated to direct a light flux from the catadioptric optical system to the refractive optical system.

46. (amended) The ~~off-axis~~ optical imaging system of claim 45, further comprising a second reflective surface, wherein the refractive optical system comprises a first lens group and a second lens group, and the second reflective surface is situated between the first lens group and the second lens group.

47. (amended) The ~~off-axis~~ optical imaging system of claim 20, wherein the catadioptric optical system comprises a concave mirror and at least one diverging lens situated so that optical radiation from the object is directed through the diverging lens to the concave mirror, and directed from the concave mirror to the diverging lens.

48. (amended) The ~~off-axis~~ optical imaging system of claim ~~47~~ 47, wherein the catadioptric optical system comprises at least four lens elements.

49. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 20.

50. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 23.

51. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 24.

52. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 27.

53. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 29.

54. (amended) A projection-exposure method, comprising:
illuminating a pattern; and
imaging the pattern on a substrate with the ~~off-axis~~ optical imaging system of claim 31.

55. (amended) An ~~off-axis~~ optical system configured to form an image of a predetermined area of an object on a surface, comprising:

a catadioptric optical system situated between ~~a first image conjugate point~~ the object and a ~~second image conjugate~~ point that is optically conjugate to the object; and

a refractive optical system situated between the catadioptric optical system and the surface and configured to form an image of the object on the surface, wherein at least one of the catadioptric optical system and the refractive optical system includes an aspheric surface~~, and the image is displaced from an optical axis~~.